Environmental technological innovation and market demand: is market orientation a missing link?

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***Abstract*— Environmental technological innovation has becoming an important step towards sustainable development for emerging country like Malaysia, and market demand is an important determinant of environmental technological innovation. However, stakeholders have neglected demand-based perspective, while designing policies centered on technological (supply) side view. Extant research also constructs a direct mechanism for the market demand–eco-innovation link. The research reported here, however, provides and investigates an indirect market demand-environmental technological innovation argument where market orientation is a mediator. The current study is motivated to produce this conceptual model for the benefit of policy makers and industry alike.**

***Keywords*—environmental technological innovation, market demand, market orientation, eco-innovation, sustainable development**

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I. Introduction

Each development must make an effort to compare the effect of social and ecological factors, as well as economic ones; of the living and non-living resource base; and of the long-term as well as the short-term advantages and disadvantages of alternative action. In the meantime, current needs and future needs must be considered. This is what initially defined as sustainable development [1], [2].

According to Brundtland Commision (1987), new technology is capable of proposing new method of saving resources and reduce consumptions [2, Para. 14]. New technology also is the key to economic growth and competitive advantage [2, Para. 14], [3]; which make it very important in the fight against poverty which threaten environment through unsustainable use of resources [2, Para. 20]. This is inline with several in-depth issues in sustainable development where each area of technology, sciences and politics has responsibility to take precaution and prevention. For example, each development program must aware of regenerative and absorptive capacities of material or energy, and maintain output growth below stipulated threshold [4].

However, new technology also can produce new ways to pollute and alter earth natural evolutionary progress [2, Para. 14]. Hence, it is important for the technological and scientific study to be responsible and take precaution against these possibilities [4]. However, it is difficult for industry to control the technology by just adopting any technology. Firms need to innovate to assure control by implementing environmental technological innovation (ET-innovation) as a sustainable development tool [5].

This paper will take a closer look into market demand effect on ET-innovation from the demand-based perspective. Demand-side view means works that looks downstream from the focal firm, toward product markets and consumers [6], [7] rather than upstream views that look into activities and internal capabilities of firms as the primary drivers of innovation [8].

II. Objectives and Significance of the Study

Policy makers normally introduce innovation and technology policies based on supply-side perspective, the demand-side view has been neglected [9]. The Malaysian government however, has begun to consider market demand approach when designing innovation initiatives. For example, PlaTCOM Ventures Sdn Bhd was established with objectives to addresses the innovation gaps through a holistic and market-driven approach and supports innovation and industrial competitiveness [10].

Other reasons worthy for the study of the effect on ET-innovation from the demand-based perspective are as the following; (1) knowledge on demand-based view is less explored, unknown and overlooked on its importance, (2) fluctuation in demand for green technology need for better understanding, and (3) competitive pressure study in demand-based view is not common in innovation study but important to improve advantage against competitor.

This paper encompasses unexplored dimension of market orientation as a mediating factor in the study of market demand relationship with ET-innovation. This area of study also have attracted research attention in other disciplines [11].

III. Literature Review

A. *Environmental Technological Innovation (ET-innovation)*

ET-innovation is a subcategory of eco-innovation [12]. Green et al. (1994) define ET-innovation as inventing, innovating and diffusing new sets of products and processes which somehow or other are inherently more environmentally friendly than the sets we currently make and use [13]. Following Green et al., ET-innovation can be classified into environmental process innovation and environmental product innovation.

Kammerer (2009) writes that an environmental product innovation is an innovation that reduce the impact along a product's total life cycle for different environmental issues, such as reduction of toxics and materials in products, improved power consumption and emission output in use phase, as well as extended use phase or recycling schemes for obsolete products regardless of whether this was the main objective of the innovation [14].

While Lin et al. (2014) describe environmental process innovation as modifications in manufacturing processes and systems with the aim of producing environmentally friendly products capable of meeting eco-targets, such as energy savings, pollution prevention, and waste recycling [15].

ET-innovation objective is to reduce impact to environment at all the physical life cycle stages [16] while maintaining economical viability [17][18], [19].

Firms develop eco-product for business advantage. In general, customers do not have natural desire or need for unsustainable product [20], [21]. Therefore, firms need to pay high attention to fulfill customer satisfaction towards their eco-product and gain advantage in the market [15] [16]. Being competitive in the marketplace will open doors for new business opportunity for firms that implement eco-innovation strategy [22].

Cost saving is also motivate firms to implement ET-innovation [22], [23]. These can be achieved with more efficient process [23]. However, saving must come later as eco-innovation's economic success will be preceded by internal R&D and high investment intensity [17], [24].

Brand reputation and image improvement also drive eco-innovation implementation [23]. According to Driessen et al. (2013), when a product is greener, it will require advanced levels of technological development, thus the reputation of the company in green technology will escalate [25].

B. *Market Demand*

Main determinants of ET-innovation can be summarized into firm specific factor, market demand, technology push, and regulation and incentives [14], [17], [26]. However, the focus of this paper will be on market demand. Market demand study is not new. Market demand study in innovation has been discussed since late 1960s [27] while the study of demand on eco-innovation started in 1990s [28], tailing the 1987 Brundtland Commission report on sustainable development.

Adner & Levinthal (2001) demand-based perspective simulation model found that in the early technological development, firms is guided by the customer need and requirement; and when market price and performance are met, technological innovation is driven by competition to attract technologically satisfied customer [7].

Understanding the above, market demand for this study is classified as customer demand and competitive pressure. Customer demand analysis focuses on identifying, understanding and responding to customer needs and creating products capable of meeting their expectations [15]. Competitor pressure on the other hand, force firms to understand the strengths, weaknesses, capabilities and strategies of the key competitors and identify their technologies capable of satisfying the target consumers' demand [18], [29].

C. *Market Orientation*

Market orientation has been a marketing concept for along time. It become popular in 1990s with seminal papers by Narver & Slater (1990) and Kohli & Jaworski (1990) [29], [30]. Market orientation also is a pillar of modern marketing study due to its significant managerial relevance [31] and an important aspect in many innovation management literatures as an important driver for a successful innovation implementation [25].

Most studies have discussed market orientation through behavioristic perspective using two approaches; the Narver & Slater (1990) approach emphasizes on culture integration within firms [29] while Kohli & Jaworski (1990) adopt an operational approach [30].

In this paper, the definition and dimensions of market orientation by Kohli & Jaworski (1990) is believed to be more suitable since its not just focus on customer and competitor in gathering intelligence but other stakeholders. Factors that effecting eco-innovation also includes regulation and incentives and other stakeholders too.

Kohli & Jaworski (1990) define market orientation as the organizationwide generation of market intelligence pertaining to current and future customer needs, dissemination of the intelligence across departments, and organizationwide responsiveness to it [30]. As reflected in their definition, they suggested three organization wide activities for market orientation: (1) market intelligence generation, (2) the dissemination of the acquired intelligence data across department and (3) responsiveness to the intelligence [30].

Market intelligence can be summarised as act of understanding customer's current and future needs and preferences; it also includes an analysis of how they may be affected by exogenous factors. Responding to the market need requires the participation of virtually all departments in a firm, thus effective dissemination of market intelligence, either formally or informally, is important to provides a platform for concentrated actions by different departments. Whereas, responsiveness is the action taken in response to intelligence that is generated and disseminated. Without responding to market needs, market orientation objectives would not be achieved [30].

IV. Proposed Model

The proposed model for this study adapt the demand pull of innovation model [32]. Klaus Rennings (1998) apparently one of the first that used the innovation model in the area of eco-innovation [28]. Base on demand-driven perspective developed by Adner & Levinthal (2000), this paper proposed a relationship between market demand and ET-innovation. The subsequent subsection will explain why the above relationship worthy of study from the demand-based view (refer figure 1).

However, the direct relationship between market demand and ET-innovation can be argued when referred to results of present researches. Several studies on market demand

relationship with ET-innovation shows an indirect relationship between the two constructs.

For instance, (a) The study by Yusuf et al. (2014) reported innovation speed as the facilitating factor in the relationship between demand and eco-product innovation implementation [33],

(b) S. K. S. Wong (2013) underscored the mediating role played by knowledge sharing in the green requirements and new green product success, and also for the relationship between green requirements and green product and process innovations [34],

(c) Test results by Huo & Shan (2013) also showed that 70% of photovoltaic (PV) market in the twenty countries has insignificant market pull factor. They suggested that in order to encourage demand pull policy making is suggested to lead the market until it achieved stable growth [35],

and (d) Kammerer (2009) emphasized empirical evidence that, with demand, customer benefits foster the implementation of eco-product innovations, their broad application and their level of novelty [14].

Hence, In this paper, market orientation is proposed to be the mediator in increasing the market demand effect towards the implementation of ET-innovation. The detail reasons will be explained in the later subsection.

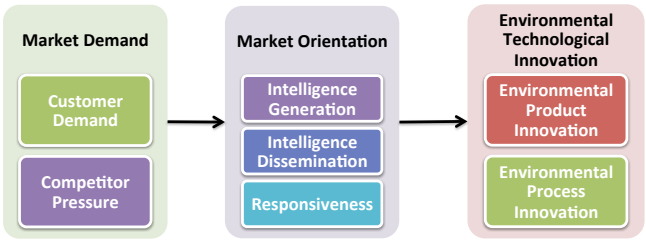

Figure 1: Market Demand-Environmental Technological Innovation Framework with market Orientation as Mediator

A. *Why Market Demand: Demand-based Study?*

The study on demand-side factors as an emerging new research direction [6] and it effect on ET-innovation are important because of the following reasons.

(1) The body of knowledge of the demand-based perspective is relatively underexplored [7], the researches are dispersed and relatively less-known [6]. Many scholars may have overlooked the extent and importance of this research perspective since it is spanning wide across innovation, entrepreneurship, and strategy studies [6].

(2) Regulators also have been designing many innovation and technology policies based on supply-side perspective while neglecting demand-side view for so long [9]. But presently market-driven perspective has started to be recognised.

(3) Malaman (1996) wrote that market demand for cleaner technology innovations is generally difficult to predict [36]. Tseng et al. (2013) have showed in his study that market demand can vary due to disturbances that may occur in actual operations [37]. Demand fluctuations may have caused by green consumers due to their difficulty to please attitude [21]. This issue is important since according to Lin et al. (2014), the demand fluctuations due to changes in market variables can affect firm's performance.

(4) Demand-based perspective includes competitive pressure which was not a common theme in eco-innovation study. Yalabik & Fairchild (2011) theoretical formulation final result confirmed the competitive pressure to attract environmentally concern customers increase the effectiveness of innovation within firms, and added that an empirical result is needed to support generalizability of the result [38].

(5) The study of competitor in demand-based perspective is crucial as more competitors enter the market, competition will be intense and some competitors will resort to imitation of successful companies. Therefore, firms need to innovate to survive [39], and maintain competitive advantage by being different [40]. While, at the same time give more attention to competitors' environmental strategies to remain relevant [18], [40].

Finally, while the study of science and technology (supply-side) provide trajectories of innovation, demand factors is crucial to direct the trajectory towards having competitive advantage in the market [41]. This is because, the demand-pull innovation research does not assume that customers' needs are constant as in technology-based innovation research; instead demand-based innovation research emphasize market change and market heterogeneity [6].

B. *Market Orientation as the Mediating Factor*

There is no study so far that use market orientation as mediator in the relationship with ET-innovation implementation. Listed below are reason for the use of market orientation concept as the mediating factor in the relationship of market demand and ET-innovation implementation.

Firstly, as market demand drive ET-innovation [26], the lack of market demand becomes barrier to ET-innovation implementation [42]. However, according to Lemke & Luzio (2014) and Ottman (2011) it is unnatural for consumer to choose unnatural (non environmental) product [21], [20]. Therefore, it is important to understand current and latent needs and push for a rise in market demand. For example, private household has impact on environmental economy estimated between thirty to forty percent. Thus, market orientation implementation on consumer market must consider nurturing and facilitating green consumer market through supplying information truthfully, providing choices and good prices, increasing confidence and developing innovative products.

Secondly, demand-based view emphasised on demand heterogeneity where when threshold of functionality required by customers being achieved, price over performance consideration would be more important [7]. A firm specific factors and different industry will have different functional need, budget and capability [43]. Heterogeneous concept and nature of firm highlight the need to generate intelligence on customer current demand,

disseminate within the firms and response with ET-innovation.

Thirdly, at certain level where customer is satisfied with function and price, competition will kick in, firm need to innovate to reduce price or increase performance through eco-product and eco-process innovation [7]. For example, Huo & Shan (2013) study on PV market in twenty countries resulted in an insignificant market pull effect towards green product when the market grew steeply [35]. According to demand-based view, the above happen because the functionality threshold has been reached. Hence, it is important for firm to gather competitors' intelligence to maintain stable market share and also stabilise between investing in product innovation or pursue process innovation.

The forth reason, Azzone & Noci (1998) emphasised that firms must focus on innovation-oriented customers and trendsetter, test solution for environmental needs and customer requirements on them for successful environmental innovation implementation [44]. Base on Dangelico & Pujari (2010), consumers are still lack of awareness on benefits of the environmental product. They are also highly concerned on competitive price, product quality, esthetic and credibility of environmental claims [45]. The market orientation factor can assist in terms of gathering information data from market and also implementing culture of information distribution, interfunctional team, and fast response at managerial level.

The fifth reason, Ken Green et al. (2000) highlighted the issue of actions that should have been taken when demand signal/information for environmental product received at a firm. According to them, the exact mechanism of these actions is still underexplored [26]. To achieve an ability to respond on demand for environmental product by customer or pressure to produce one by competitors, a firm needs to; have a sales team a that attune to customer demand and make sense to consider product or process innovation, have good inter-department relationship where related department can discuss and relay information, and finally, have the ability to respond to request from the market.

The sixth reason, Kuo (2003) emphasised the importance of understanding the market before developing new green products. He also draws our attention to the criticality of understanding the possibility of manufacturing these green products from cost, material, and marketability perspectives [46]. This consensus issue between customers and manufacturers imply for responsive action when intelligence data gathered and disseminated (market-oriented approach).

Subsequent reason, Kanchanapibul et al. (2014) stressed the need for business to focus on delivering satisfaction. They are confident if consumers' environmental belief is consistent, market demand will increase [47]. Although to achieve business success, firms still need to understand customers, competitors, and regulation and response to this intelligence. The customer demand for solutions against environment problems and they also understand the impact of business toward the environment. Therefore, it is critical for firms to understand this needs and apply market orientation, not only for business success, but also for survival.

v. Conclusion

This paper has showed that market demand direct relationship with ET-innovation from the perspective of demand-driven is important and novel. This paper also theoretically argue that an indirect relationship between market demand and ET-innovation will give more impact with market orientation as the mediator. The question, 'is the market orientation a missing link?', can be only be truly answered with an empirical research base on the proposed framework.

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